THE TOTORA (*SCIRPUS CALIFORNICUS*) IN ECUADOR AND PERU

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The totora, a bulrush, is widely distributed in the Americas and also on Easter Island and Hawaii. Throughout most of its range it has been used by man in a variety of ways. It was mentioned by the early chroniclers of Peru, who particularly marveled at the floats made from the reeds that were used for fishing in the ocean. Acosta (1940) in 1590 wrote of Lake Titicaca: "It brings forth a great abundance of a kind of reed, that the Indians call totora, which serves for a thousand uses, for it is food for horses, for pigs and for the people themselves, and from it they make houses and fire, and boats, and whatever else they need the Uros find in their totora." To this day the totora continues to serve man in many ways in much of Latin America, and nowhere is it more important than it is among the remnants of the Uros who still inhabit Lake Titicaca. Their houses (Fig. 1) and floats are made of it today, and they still use it for food. In fact, the very islands on which they live are made of matted totora reeds. In the present account I shall discuss the uses of the totora and something of the botany of the plant. My comments will be largely confined to Ecuador and Peru, where I carried out field work in 1975.

COMMON NAMES

In the present account the name totora will be used to refer to *Scirpus californicus*. Although this word, sometimes given as "tutura" or "tortora," is apparently the one most commonly used in northwestern South America, other Indian names—"matara" and "mirme" (or "merme")—are sometimes employed, and in Spanish the plant is often referred to as "junco" or "enea." Unfortunately all of these names may also be used for the cattail (*Typha*) and various rushes (*Juncus*). In some places a distinction is made as to which name is used for a particular plant. For example, at Lago Junín, totora is used for a species of *Juncus*, and merme for *S. californicus* (John W. Rick, in litt., 1974). In some places in Ecuador the name "totorilla" is used for the small bulrushes belonging to the *Scirpus americanus* complex, and I shall employ it here in that connotation.

In California, Mexico and Guatemala, *S. californicus* is often known as "tul" or "tule," words also often used for cattails. Possibly "ytztollin," which Hernandez (1942) says is a large kind of sedge used to make mats and as forage for donkeys, and whose roots are used for fever in Mexico, is also *S. californicus*. Sahagún (1938), after relating that a plant called "petlatollin" is a rush that is used medicinally and to make mats, states that there are other rushes that are used to make mats that are triangular and are called "nacacetotli." Inasmuch as *S. californicus* usually has a triangular stem, perhaps the last name is applicable.

There are a number of places called totora or totoral (a place where totoras grow) in both Peru and Ecuador. I visited Totoras near Ambato, Ecuador, and

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Fig. 1. House made of totora on an island in Lake Titicaca. The island itself is composed largely of totora reeds. Bundles of harvested reeds may be seen in the background.

found that totoras still grow there, but at Totoracocha, near Cuenca, there is neither totoras nor a lake (cocha) today; the area is occupied by houses.

USES

1. *Floats or Rafts*

Reeds have been used in various parts of the world for the construction of watercraft, but there is sometimes confusion as to the plant employed. Edwards (1965) has given an excellent account of distribution, construction and uses of watercraft in western South America so that only a few observations need to be made here.

In Ecuador, Edwards records three places where reed boats of totora were used: Lago San Pablo (near Otavalo), Yaguarcocha (near Ibarra) and Lago Colta (near Riobamba), all highland sites where totoras occur in some abundance. I observed the floats, "caballetes," at San Pablo, and I agree with Edwards that these are crudely constructed in comparison to the "caballitos" and "balsas" of Peru. I observed no caballetes at Yaguarcocha, although I was told that they are still made there. At both San Pablo and Yaguarcocha the floats are not left near the lake but are carried to the houses after use so that ordinarily they would not be seen by the casual visitor. I have not been able to verify the occurrence of reed boats at Colta. Robinson (1966) mentions that the Indians there used rafts of balsa (*Ochroma*) logs, and I observed such there on my visit. It is not known whether reed floats were used in Ecuador in the prehistoric period.

Reed boats are more widely used in Peru than in Ecuador, and their early occurrence there is well documented in the chronicles. The well known balsas

Fig. 2. Balsa on Lake Titicaca. Stands of totora may be seen on the right and in the background.

of Lago Titicaca are made of totoras. Sails also made of totoras were sometimes used (Yacovleff and Herrera, 1934; Parodi, 1933), although I did not see any balsas with sails on either of my visits to the lake. Most of the boats constructed there today are similar to those shown in Fig. 2. However, a much smaller balsa with one end truncate is also used. These are called "maraias," and the smaller size is reported to result from the scarcity of totoras in the part of the lake where they are made (McIntyre, 1973). I also observed balsas of the typical kind in a small lake just east of Juliaca. The only other highland site where Edwards reports balsas is at Lago Junín. However, John W. Rick, who has done extensive field work there recently, has not observed balsas.

According to Edwards, reed craft on the Peruvian coast are also rapidly disappearing. A large number of caballitos (Fig. 3) made of totoras, however, were still being used for fishing at Huanchaco on the north coast in 1975. The caballitos that Edwards observed on the south coast were quite different from those in the north, and he reports that these were made of *Phragmites* and *Scirpus*, which were usually obtained at Mala. I have not visited this region, but I have a report from Miguel Holle (in litt., 1976), who saw a single caballito at Bajama, a fishing village in the Mala valley. This caballito, apparently quite different from those described by Edwards, was made of a single pole curved at one end and was covered with a reed that he identified as *Typha*, which was reported to come from Lurin and Cerro Colorado. He visited the latter place and found marshes filled with *Typha* but no large *Scirpus*. In earlier times Acosta (1940) reported seeing caballitos being used at Callao, near Lima. Dr. Holle and I made a search of the marshes near Callao and found *Typha* in abundance, as well as totorillas, but no large *Scirpus*. A search of the herbaria at the University of San Marcos failed to turn up specimens of *Scirpus*

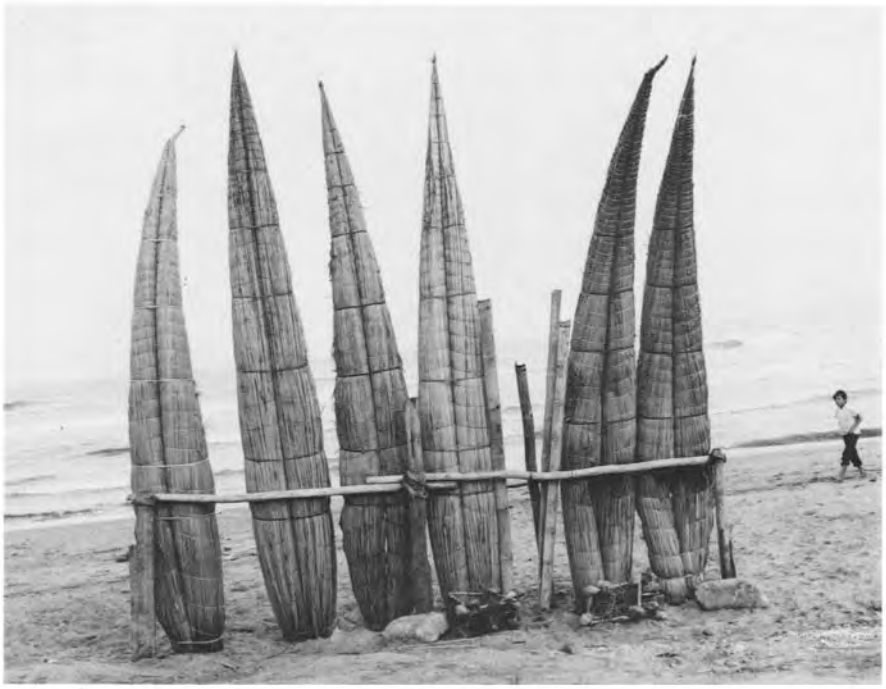

Fig. 3. Caballitos at Huanchaco, Peru.

californicus from this area, but specimens of *S. validus* were found.[2] This species is somewhat similar to *S. californicus*, but I have no information that it is used in the same ways as that species. It is, of course, possible that *S. californicus* at one time grew near Callao or that such material had been obtained from elsewhere for making caballitos there. It is also possible that cattails were used. Parodi (1933) reports a balsa made of cattail in Argentina. However, I am of the opinion that cattails are inferior to totoras for this purpose. At Huanchaco, totoras are not common and cattails are found in some abundance near by, but they are not used in the construction of the caballitos.

Edwards gives other examples of reed floats from many parts of the Americas, but lists none for the region between Mexico and Ecuador. Reed floats or "balsas de enea" or "junco" are cited by Pérez (1951) for Colombian lakes in early times. The plant used for their construction is not known, but the totora is found in highland Colombia. David N. Smith (in litt., 1976) has written that he has observed small boats made of totoras in the Calderas area of Guatemala. "The boats," he writes, "are vaguely mindful of the caballitos from Huanchaco, but are not as well built."

Spanish names appear to be used almost exclusively for the reed floats in Ecuador and Peru today. In reply to my inquiry at Lake Titicaca I was informed that the Indians sometimes use the Quechuan word, "wampu" or "huampu," for their balsas.

2. *Mats*

Probably the greatest use of the totora today in both Ecuador and Peru is the making of mats or "esteras." These mats served in many ways in ancient Peru

[2] Callao, Rio Rimar, *E. Zuniga*, Aug. 4, 1942; Lima, *Oscar Tovar 6904*; Miraflores, *K. Maish 64* (USM).

Fig. 4. Otavalo Indians with esteras at Lake San Pablo, Ecuador. Their cabellete may be seen behind the woman in the middle.

(Cobo, 1890) just as they do today — as beds, rugs, windbreaks, fences, storage bins, roofs and even entire houses. They seem to be much appreciated for these purposes.

The making of esteras is an important cottage industry in many places in highland Ecuador. Important centers are at San Pablo (Fig. 4), Colta and near Cuenca. At one time totoras grew near Quito where they were used for making esteras (Alcedo, 1967), but the area where they grew has long since given way to urban development. Esteras, however, are still widely sold in Quito (Fig. 5), the principal source being San Pablo. There a family of three, working about eight hours a day, can make three large esteras (1.8 × 1.3 meters). These sell for about 15 sucres (about 70 cents U.S.) each, and they are taken by truck to Quito where they sell for 20 sucres (about 90 cents) (Villarroel, 1975), although American tourists may have to pay more. Robinson (1966) has given a detailed account of the estera industry at Colta. The methods used for making esteras in Ecuador appear rather similar to those described for Mexico (Foster, 1948) and Guatemala (McBryde, 1945). All the esteras I saw in Ecuador were made of totoras.

Two types of totora esteras were observed in Peru. Woven esteras similar to those of Ecuador were seen in two markets in Lima, and in both places the vendor informed me that they had come from Cajamarca. Woven totora esteras were also observed in Trujillo and they were said to have come from the "sierra." Woven esteras made of carrizo (*Phragmites*) were also seen at Trujillo.

Twined esteras, made simply by interweaving a cord or a reed at intervals of 20 cm or so (See Figs 6 and 7), seem to be the more common type in Peru, and these are made either of totoras or cattails. I saw such esteras made of cattails between Moche and Salaverry on the north coast, and also at Callao.

Fig. 5. Esteras for sale in market in Quito. The baskets are made of carrizo.

Fig. 6. Esteras used as roofs in market stalls at Puno, Peru.

Twined esteras of totora were seen at Huanchaco and also at Puno (Fig. 6) where they are very common. Carlos Ochoa informs me (in litt., 1975) that twined esteras are used at Pomacanchi (Fig. 7). No esteras were observed at Cuzco or Arequipa, although in the former place I saw bundles of cattails in the market and was told that they are used for making mattresses.

The Spanish word estera seems to be the one most commonly employed for mats in both Ecuador and Peru. The Quechuan word "q'esana" (or "qquessana") I found in use only among the Indians at Puno. The word "petate," however, is often employed in both countries. Cobo (1890) writes, "In some parts [of Peru] the Indians make very neat esteras of narrow, long rushes, especially in the city of Lima, and in the pueblo of Lambayesque in the diocese of Trujillo. They call these esteras "Petates," which is the Mexican name...." Cobo arrived in America in 1596 so it is possible that the name petate had already been introduced to Peru by the Spanish by that time, but it is perhaps more likely that the word had reached there in pre-Conquest times.

3. *Food*

It is also Cobo (1890) who informs us that in the area of Lake Titicaca the roots of the totora, which are white and tender, serve as bread for the Indians and are sold in the plazas of their pueblos. Today one may still find the "roots" of the totora sold in the streets of Puno, and insofar as I am aware it is only in the area of Lake Titicaca that they are used for food by humans.[3] Nearly all writers have referred to the part eaten as roots; one writer has called it a rhizome (Yacovleff and Herrera, 1934). However, it was only the stems that I observed being sold. The culms are pulled from the water and break from the rhizome, and the basal part (20 to 30 cm) is eaten raw after the outer layers are peeled away. Parodi (1933), who correctly refers to the part eaten as the stem, describes it as being more or less insipid, whereas La Barre (1948) is rather eloquent in his praise, stating that "in tenderness and delicacy of flavor it far surpasses the best hearts of celery." My notes made at the time of eating one describes it as "rather tasteless."

A number of writers have referred to the use of totoras as feed for livestock, an exception being Cordero (1950), who states that livestock will not eat sedges. I learned that the stems of both the totora and totorillas were used for feeding livestock in Ecuador, and I observed cattle grazing in them at San Pablo.

4. *Other Uses*

Fans or "aventadores" are commonly made from the totora in highland Ecuador. These small fans are seen for sale in most of the markets and are an almost indispensable item for starting fires and keeping them burning in the rarefied atmosphere.

A number of writers state that totoras are used to make baskets, but I saw only one, in a market in Quito, that I was certain was made from the totora. The most common construction material for baskets, particularly the larger ones, in both Ecuador and Peru is carrizo (*Phragmites*). Many other grasses, sedges, rushes and palms as well are used for making smaller baskets in both countries. Acosta-Solis (1961) states that the totorilla is superior to the totora for making baskets.

Both Acosta (1940) and Cobo (1890) describe bridges being made of totoras

[3] Yanovsky (1936) gives several references to the use of the rootstocks, young shoots, pollen or seeds of various species of *Scirpus* for food in North America, but *S. californicus* is not included. See Cárdenas (1969) for the use of the totora as food in Bolivia.

Fig. 7. Storage bin or "tacke" made from the totora at Pomacanchi, Peru. The roof of the house on the left is made of totoras covered with ichu (*Stipa*). The totoras come from Laguna de Pomacanchi (Dpto. Cuzco, alt. 3700 m). (Photograph by Carlos Ochoa.)

in the area of Lake Titicaca. These bridges, however, were not built over the water, but the reeds were packed into the water until they provided a surface over which a man could cross.

Dried totoras have also been used for fires, but this is hardly an unusual use, for a great many more or less herbaceous plants are so used in many parts of the sierra where fire wood is often scarce.

CULTIVATION

Although it is possible that the totora was cultivated in prehistoric times, I know of no evidence that it was. Indeed, such evidence might be very difficult to obtain.[4] It would seem, however, that such agriculturally advanced people as those of Peru might have had no difficulty in introducing this useful plant into

[4] After the above was written, I came across the paper by R. R. Kautz and R. W. Keatinge (Amer. Antiq. 42: 86–97. 1977) in which they report finding totoras in excavations on the north coast of Peru in an area where sunken gardens are known. Although exact dates are not available for the site, the authors consider it relatively late, possibly in the Lake Horizon (A.D. 1476–1534) or even in early Colonial times. The old sunken gardens, one of which is used today by a fisherman from Huanchaco for growing totoras, range in size

Fig. 8. Totoras cultivated in pozos at Huanchaco, Peru.

new areas, probably by means of the rhizomes. On the other hand, it is entirely possible that this species' extensive range developed entirely through natural means, probably through the dispersal of seeds by water fowl. There are, however, records of its cultivation in historic times.

The earliest evidence of the attempted cultivation of the totora was supplied to me by María Rostworowski de Diaz Canseco. In the General Archives of Peru she has found an account of the sowing of the seeds of totora at Huaman, a pueblo near Trujillo (Anonymous, 1692), and another one (Anonymous, 1669–1684) that refers to the sowing of the totora in a lake near the pueblo of Quilcay in the Lurin valley. It cannot be certain, of course, that the totora referred to is *S. californicus*. The sowing of seeds, if literally meant, is somewhat surprising, for one might expect rhizomes to have been planted, as is now done in other places.

At present the totora is cultivated in pits or "pozos" at Huanchaco (Fig. 8); the cultivation apparently began in the 1930's (Edwards, 1965). The pozos now extend for more than a mile along the coast and those nearest the ocean are provided with esteras for windbreaks. The people in the area, according to Edwards, formerly obtained their totoras at Chan Chan and started cultivation

from 230 to 38,250 square meters. This appears to be more land than would be needed if only totoras were grown, the authors point out. A pollen analysis of the midden revealed not only *Scirpus* but maize and other agricultural plants as well. Thus, the authors suggest that the gardens were used for a variety of crops. They believe the totora was also cultivated, but this does not necessarily follow. Pollen of other sedges, *Typha*, and *Potamogeton* was also recovered. These plants probably represent introductions into the gardens by natural means, possibly birds, and the totora could well have entered by the same means. Thus, although the totora is definitely present, it did not necessarily have to be cultivated. The distinct possibility remains, however, that the totora was introduced to coastal Peru by man.

on the coast when the price of those from Chan Chan was increased (Edwards, in litt., 1974). I spent a morning searching Chan Chan for totoras. In the old walled city I observed rectangular ponds, perhaps the remnants of the water supply or sunken gardens of the ancient city. These were largely filled with cattails and included a few totorillas but no totoras. I finally located a single clump of totora south of Tschudi in another pond largely dominated by cattails. Could it have been the growing scarcity of the totoras at Chan Chan that led to the increase in price? Perhaps cattails tend to replace totoras in coastal areas, which might also explain the absence of totoras at Callao today.

The totora is deliberately planted at Lago Junín, as I learned from John W. Rick (in litt., 1975). The planting is a recent development, according to his informant, undertaken because of the fluctuating water level in the lake resulting from the installation of a hydroelectric dam. The primary reasons for the planting, according to the informant, is to provide food for frogs, feral guinea pigs and cattle. The hunting of frogs for food is important locally, and as Rick points out, the totoras probably create an excellent habitat for them rather than serving as food. The totoras are also used for making chair seats, roofs and mats.

Although Acosta-Solis (1961) states that all of the stands of totora in Ecuador are natural, there is evidence for cultivation in two places. Plantings have been made at Colta (Robinson, 1966). Plots are plowed at or near the level of the lake, holes are made in the mud and "stalks" of totora from other parts of the lake are transplanted in groups of three about 20 cm apart. Cordero (1950), whose observations were made sometime before 1911, states that there are parishes, such as Llacao near Cuenca, where the totora is propagated and cared for. In 1975 I found a nearly rectangular swampy area at Llacao that was filled with totoras. Although the local inhabitants could supply no information as to the origin of the totoras, I feel that this may well be one of the plots to which Cordero makes reference.

Although it is clear that the totora is cultivated in some places today, it can hardly be considered a domesticated plant, for the plants from cultivated sites do not differ from plants found in supposedly natural stands.

BOTANY

1. *Taxonomy and Distribution*

Koyama (1963), in the most recent taxonomic treatment of *S. californicus*, divides the species into two subspecies: subsp. *californicus* and subsp. *Tatora*, and he recognizes three varieties within subsp. *californicus*. Inasmuch as he cites very few specimens in his study and Beetle (1941) includes only a very few from South America, it seems desirable to document the distribution of the two subspecies in the areas for which I have information. All specimens for which the herbarium abbreviation is not given are deposited in the herbarium of Indiana University.

A. **Scirpus californicus** (C. A. Meyer) Steudel subsp. **californicus** var. **californicus**.

COLOMBIA. Dpto. Cundinamarca: Bogotá, 2640 m, *B. Guevara Amortequi 209* (US); between Suba and Tabio, *Bro. Ariste-Joseph A743*; Com. Putamayo, Valle de Sibundoy, 2200 m, *J. Cuatrecasas 11679* (US). Prof. A. Fernández-Perez of the Instituto of Ciencias Naturales writes (in litt., 1975) that they have specimens in their herbarium identified as *S. californicus* from laguna de Suesca

and Fiquene in Cundinamarca, lago de Tota in Boyaca, and Cocha in Putumayo; the information on some of these specimens indicates that the plants were used for making esteras.

ECUADOR. Prov. Imbabura: Lago San Pablo 2600 m, *Heiser 7501*; Yaguarcocha, 2200 m, *Heiser 7503*; Lago Cuicocha, 3050 m, *Heiser 7090*; Prov. Cotopaxi, near Latacunga, ca. 2800 m, *Inés Padilla*; Prov. Tungurahua, Lago Yumbo, 2600 m, *Heiser 7521*; Totoras, 2600 m, *Heiser 7513b*; Rio Ambato, 2700 m, *Heiser 7516*; San Javier, 2040 m, *Heiser 7555*; Prov. Chimborazo: Lago Colta, 3200 m, *Heiser 7520, 7536*; Prov. Azuay: Baños de Cuenca, ca. 2500 m, *Heiser 7557*; Llacao, 2700 m, *Heiser 7559.*

If the report from Espinosa (1949) of "*S. totora?*" from near Loja is included, it can be seen that the totora extends the length of the sierra in Ecuador. The most usual habitat is the margins of lakes, but the plant is also found along some river banks or in small marshy areas. In altitude the range is from 2000 to 3200 m. No totoras were found in lakes at higher elevations (Pisayambo, 3600 m, and Anteojos, 4000 m). Seed (achene) set was examined in all populations when mature inflorescences were found, and considerable variation was found. The best seed set was at Yaguarcocha (2200 m), very few seeds were found nearby at San Pablo (2600 m), and the only population in which no seed was found was at Colta (3200 m). The most obvious correlation seems to be with altitude. The failure of seed to be observed at Colta raises the question as to whether the totora may owe its introduction here to man. On the other hand, the original introduction could have been by seed by natural means, and its subsequent spread could have been entirely by vegetative means.

PERU. Dpto. La Libertad: Sausacocha, 3100 m, *A. López & A. Sagastegui* ("used for making esteras") (HUT); *I. Sanchez Vega 1367;* Salaverry, 40 m, *A. Sagastegui* (HUT); near Puerto Chicama, *N. Angulo & A. López* (HUT); Chan Chan, *M. Ovilardi* (SMF); Huanchaco, 10 m, *Heiser 7569.* Dpto. Ancash, Laguna de Llanganuco, 3750 m, *Miguel Holle.*

The altitudinal range of the subspecies in Peru — from sea level to 3750 m — is rather remarkable. This subspecies is known from the coast in both temperate North and South America, but in the tropics outside of Peru it is strictly a highland species. Thus one may ask if perhaps man has not been responsible for its increase in range in Peru. There are no reports for this subspecies from southern Peru, which may simply indicate a lack of collecting.

Only a few records of seed set are available for Peru. Plants at Huanchaco do set fair amounts of seed. D. N. Smith sent me a few seeds from Sausacocha and remarked that seed set was very poor at this locality. Several of the inflorescences from the specimens at Laguna de Llanguanuco appeared to be mature but did not yield a single seed.

B. **S. californicus** subsp. **Tatora** (Kunth) T. Koyama.

PERU. Dpto. Huanuco: Lauricocha, *A. Cardich* (USM). Dpto. Junín: La Aroya, 3720 m, *P. Gutte* (SMF); Lago Junín, 4100 m, *John W. Rick.* Dpto Cuzco: Laguna Huacarpay, 3400 m, *René Chavez.* Dpto. Puno: Cuicuito, *P. Aguilar Fernández 37* (USM); Lago Titicaca, 3800 m, *Heiser 7586.*

This subspecies is found at higher altitudes than the previous one; thus far there are no records of the two occurring together. Specimens from Lake Titicaca

showed good seed set. Other specimens were not mature enough to determine seed set.

Koyama (1963) lists four differences between the two subspecies, and of these the very condensed inflorescences of subsp. *Tatora* as opposed to the more open inflorescences of subsp. *californicus* seem to be the most reliable distinguishing character. Both Koyama and Beetle (1941) indicate that the culms of subsp. *Tatora* are lighter green than those of subsp. *californicus*. I can make no distinction between the two in this regard in herbarium specimens, nor did I record any differences in the field. However, when the plants are compared in greenhouse cultures, it is apparent that the culms of subsp. *Tatora* are much darker green than those of the other subspecies, contrary to the earlier observations. Other differences were also noted in the greenhouse. All accessions of subsp. *californicus* are rapid growers, reach heights of two to four meters, have broad culms and produce several flowering culms in a few months, whereas accessions of subsp. *Tatora* grow slowly, ultimately becoming about two meters tall, and take nearly a year to give rise to a single flowering stalk. Moreover, the culms of the latter are much narrower and more decidedly triangular. The difference in the inflorescences noted above is maintained in the greenhouse cultures. One might, in fact, be justified in regarding the two as distinct species as was done by Beetle (1941). However, before doing so, more investigation is needed of the Chilean lowland plants with condensed inflorescences. Koyama has assigned the Chilean plants to subsp. *Tatora*, whereas Beetle places them in *S. californicus* var. *tereticulmis* (Steudel) Beetle.

CHROMOSOME NUMBERS

A chromosome count of $n = 34$ has recently been reported for *Scirpus californicus* from Texas (Schuyler, 1976). Counts of both $n = 32$ and $n = 34$ were obtained for subsp. *californicus* and counts of $n = 35$ for subsp. *Tatora* in the present study (Table I). The fact that the latter has a different chromosome number from the former might perhaps be used as additional evidence for considering it a species. However, aneuploid series within a species are not unusual in the family Cyperaceae.

GREENHOUSE CULTURE

Seeds from a number of localities from Peru, Ecuador, California, and one from Easter Island were sown in pots. Good germination was secured only on the accessions from Easter Island and the two accessions from Lake Titicaca. A very few seedlings were obtained from the samples from San Pablo, Ecuador and Santa Barbara, California (from D. M. Smith). The seedlings kept developed into healthy plants.

Rhizomes from Ecuador, Peru and California were grown in eight-inch pots and generally kept in saucers or trays filled with water. However, some plants not kept in water and receiving only regular greenhouse watering appeared to do as well as the others. Moreover, some plants were allowed to remain under a bench for two months without watering, and at the end of that time it was found that they were still alive.

All of the plants flowered and produced some seeds, but seeds taken from these plants failed to germinate. Seedlings, however, were often observed in the parent pots and came up abundantly in pots of other plants nearby. Thus it is apparent that germination is possible, but that a reliable technique for germinating them artificially remains to be discovered.

TABLE I

Chromosome Counts in *Scirpus*[a]

Locality	Specimen	Count
S. californicus subsp. *californicus*		
United States: Calif., San Luis Obispo Co. Los Osos Creek	*Dirk Walters*	$n = 34$ (2)[b]
Ecuador: Prov. Imbabura	*Heiser 7501*	$n = 34$ (2)
Ecuador: Prov. Tungurahua	*Heiser 7516*	$n = 32$ (3)
Ecuador: Prov. Chimborazo	*Heiser 7520*	$n = 32$
	Heiser 7536	$n = 32$
Peru: Dpto. La Libertad	*Heiser 7569*	$n = 34$
Chile: Easter Island	*John Tuki*	$n = 32$ (6)
S. californicus subsp. *Tatora*		
Peru: Dpto. Junín	*John W. Rick*	$n = 35$
Peru: Dpto. Cuzco	*René Chavez*	$n = 35$
Peru: Dpto. Puno	*Heiser 7586*	$n = 35$
Bolivia: Dpto. La Paz	*Edward Zapata*	$n = 35$

[a]Counts made from pollen mother cells of plants grown in the greenhouse at Indiana University. Specimens of all accessions are deposited in the herbarium of Indiana University.

[b]If counts were made from more than one plant the number of plants is given in parentheses. However, it is possible that the different plants of a single accession are all derived from the same clone except for the plants from Easter Island, which were grown from seed.

Hybridization was attempted between the two subspecies. Emasculation was not attempted, but pollen from one plant was shaken onto the inflorescences of another one in which the flowers were just opening. As the flowers of this species are strongly proterogynous, it was thought that some of the seeds of the second plant might give rise to hybrids rather than to selfs. The seeds failed to germinate.

THE TOTORA OF EASTER ISLAND

In an earlier paper (Heiser, 1974), following the treatment of Koyama (1963), I considered the totora of Easter Island a variety, *S. californicus* subsp. *californicus* var. *paschalis* (Kükenthal) Beetle. Since that time I have had an opportunity to grow the totora of Easter Island, and I see no basis for continuing to recognize it as a distinct variety.

The finding that the totora of Easter Island is the same as the American plant might seemingly lend strength to Heyerdahl's (1971; Heyerdahl and Ferdon, 1961) claim that the totora was introduced to Easter Island by ancient Peruvians. He (1971), however, held the opinion that the plant reproduced only vegetatively; thus apparently rhizomes would have had to be introduced. The discovery that the totora of Easter Island reproduces sexually indicates that the plant could have been introduced through seeds. This does not mean, of course, that man could not have introduced the plant by rhizomes, or for that matter, by seed. However, I feel that a case for an introduction by birds is even stronger, for as the totora is self-compatible the introduction of a single seed could have led to the establishment of the plant on Easter Island.

Heyerdahl points out that the totora was used on Easter Island in many of the ways it was used in Peru. He (1952) maintains that the rafts used on Easter Island are strikingly similar to the caballitos of Peru and reproduces an old drawing to back his claim. The drawing shows a man with what appears to be little more than a bundle of reeds which are shorter than the man himself. I fail to see any great similarity to the caballitos of Peru. Moreover, if the use of the totora on Easter Island results from diffusion, the idea did not necessarily have to come from the Americas, for various kinds of reeds had uses similar to those of the totora in many parts of the Old World. Thus, although the totora almost certainly was introduced to Easter Island from some place in the Americas, the idea of its various uses did not necessarily arrive with it.

SUMMARY

The totora (also known as matara and merme), *Scirpus californicus*, is widely used in Ecuador and Peru for a number of purposes. Floats made from it are still found at Lake San Pablo and Yaguarcocha in Ecuador and at Huanchaco and Lake Titicaca in Peru. Totora mats of highland Ecuador are woven, whereas woven mats are rare in Peru where twining seems to be the common method. Although commonly known by the Spanish name esteras, the mats are sometimes referred to as petates, a Mexican name, which may have reached the Andes in pre-Conquest times. Totoras are also used to make fans and baskets, and as food for both man and animals, the former only in the area of Lake Titicaca. The totora may have been cultivated in prehistoric times. The extensive altitudinal distribution and the apparent lack of seed set in some highland lakes suggest that man may be implicated in its spread. The totora is definitely known to be cultivated in both Peru and Ecuador in recent times. The totora comprises two subspecies: subsp. *californicus* found in the highlands of Ecuador and in both highland and coastal sites in Peru, and subsp. *Tatora*, confined to the highlands of Peru. There may be some justification for considering the two as distinct species. Chromosome counts of $n = 32$ and 34 are reported for subsp. *californicus* and $n = 35$ for subsp. *Tatora*. Plants of both subspecies were found to grow well in the greenhouses at Indiana University. The totora of Easter Island, previously regarded as a variety of subsp. *californicus*, was found to be virtually identical to American populations of the subspecies. Although Heyerdahl has claimed that the totora was introduced into Easter Island by Peruvians in prehistoric times, it is pointed out that birds are equally, or more likely, responsible for its introduction there.

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BOOK REVIEWS

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crops. A major food source in West Africa is the white or Guinea yam (*Dioscorea rotundata*), and in the Pacific region it is the taro (*Colocasia esculenta*). Cassava (*Manihot esculenta*) is of immense importance in Africa and South America. There are in addition to these starchy staples a fair number of other plants that yield edible roots and tubers. Unfortunately even the major root and tuber crops like yams, aroids, and cassava have generally been considered unsatisfactory nutritionally since their protein content is so low. Indeed cassava usually contains less than 2% protein but the white yam often contains 5% to 8% protein, and progress has been made in the breeding of yams to increase their protein content (over 10% protein has been achieved so far).